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AUTHOR Peck, Hugh I.
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ABSTRACT

The effect of certification status on the performance of mathematics teachers and their students was studied in a pilot study in Mississippi. Four routes of entry into teaching were compared: (1) college of education; (2) college of arts and sciences; (3) adding an endorsement to certification; and (4) emergency certification. Participants were 52 of 123 first and second year mathematics teachers and 1,469 of the 5,602 students enrolled in their classes. Outcome variables were: (1) teacher performance; (2) student performance; (3) student attitude; (4) student perception of teacher effectiveness; and (5) teachers' command of mathematics content. No specific line of entry stood out as clearly superior. Graduates of colleges of arts and sciences seemed to possess somewhat greater content knowledge and to perform almost equally well as did teachers who were graduates of colleges of education. Teachers on emergency certificates showed some tendencies to perform and achieve less effectively, but the differences were not statistically significant. Students perceived graduates of colleges of education as more effective, but no significant differences were found in student achievement. The study was not able to obtain sufficient data on student achievement to draw significant inferences. Results indicate that it would be possible to perform a large, multistate study using the design and methodologies of this pilot study. (SLD)

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The Effect of Certification Status on the Performance of Mathematics Teachers: A Pilot Study

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by
Hugh I. Peck
Associate Professor
Department of Educational Psychology
Bureau of Education Research and Evaluation
College of Education
Mississippi State University

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Introduction

This presentation is a brief review of a final report (pp. 154) presented to the Southeastern Education Improvement Laboratory (SEIL) by the Bureau of Education Research and Evaluation (BERE) in the College of Education at Mississippi State University, January 1988. It presents the results of the final of three grants from SEIL to BERE in its continuing concern for the teacher labor market. These studies were initiated through the efforts of the Chief State School Officers in the southeast because of their concern with the quality and quantity of mathematics teacher in their region. The research was operational from October 1, 1986 through June 30, 1987 and was funded for $30,000. Two earlier related studies dealt with the feasibility of such as regional longitudinal study and a research design plan for such a study. Readers with an extensive interest in the supply and demand of mathematics teachers can request a full copy of the final report from SEIL or BERE. Because of the brief time allotted, this presentation will of necessity omit many of the details of the study; yet will present the design, the methodology, and the results.

Statement of the Problems

Though debates may continue regarding teacher shortages; state departments of education are providing alternate or irregular routes to certification and teacher preparation institutions are carefully scrutinizing and modifying their training programs. Research related to the impact of irregular routes to teaching on the performance of teachers or their students is sparse.

The purposes of the study were to determine if the route of entry into mathematics teaching had an effect on the performance of teachers or their students and to determine if a research design plan established for a longitudinal, multistate study was applicable and operational. The study aptly illustrates the interdependence of policy decisions relating to alternate routes of certification to research on teacher performance.

The following are the research questions addressed by the project:

1. What overall differences exist among mathematics teachers who have taken different routes of entry into mathematics teaching with respect to the following characteristics?

   A. level of general knowledge?
   B. level of mathematical knowledge?
   C. level of pedagogical knowledge?
   D. attitude toward mathematics?
   E. attitude toward teaching?
   F. development of career interests in mathematics?
   G. development of career interests in teaching?
   H. self-perceived command of mathematics content?
   I. self-perceived teaching effectiveness?
   J. expectations for student performance?
   K. knowledge of student performance levels?

L. students' patterns of interest in a mathematics career?
M. students' patterns of interest in a teaching career?

2. What overall differences exist among mathematics teachers who have taken different routes of entry into mathematics teaching with respect to the following teaching outcomes:

A. level of classroom teaching performance?
B. performance levels of mathematics students?
C. attitudes of students toward mathematics?
D. students' perceptions of their teachers' command of mathematics content?
E. students' perceptions of their teachers' effectiveness?

3. What relationships exist among route of entry into mathematics teaching, selected teacher characteristics, and selected teaching outcomes?

Design

Four areas related to the research design are briefly presented in this section are research design, sampling procedures, instrumentation, and statistical analysis.

Research Design

The research paradigm utilized in this study is referred to by Campbell and Stanley (1966) as a "data analytic design." Ary, Jacobs, and Razavich (1985) call such research "ex post facto, so characterized because variations in the independent variables have already been determined in the natural course of events" (p. 147). The traditional concepts of dependent and independent variables are not as useful to understanding this design as the more applicable terms of "input" variables, defined as the route of entry the teacher has taken into the mathematics teaching profession. Also, "output" variables are defined as student and teacher outcomes in achievement, performance, and attitude. "Intervening" variables are those, such as experience and college courses taken, that occur during the study. "Descriptive" variables are used to identify the subsets of the study populations.

The Mississippi field test of the longitudinal research uses as input variables the four routes of entry into mathematics teaching available through the Mississippi Department of Certification and specifically defined in this report under "Definition of Terms." Briefly, the four routes of entry were:

*College of Education used when a teacher entered teaching through the traditional routes.

*College of Arts and Sciences used when a teacher graduated from a college arts and sciences and thus, enter teaching by scoring high enough (51%) on the NTE.

*A teacher who added a mathematics endorsement to an existing certification was considered an add-on route.

*An emergency certificate was the final method for beginning to teach mathematics in Mississippi.

The output variables are explicitly defined in sections on "Definition of Terms" or "Instrumentation." In the SEIL certification status math study, the major dependent variables were:

*performance on the Mississippi Teacher Assessment Inventory

*performance on the National Teacher Examination; professional knowledge and mathematics specialty areas

*mathematics perception for teachers and students as measured by the Soares Math Attitide Inventory

*student performance on the 8th and 11th grade Mississippi Basic Skills Assessment Program (BSAP)

*student performance on the 11th grade Functional Literacy Examination (FLE)

Intervening or descriptive variables considered in the study were:

*level of math content emphasis in preparation
*teacher self-concept
*student self-concept

Sampling Procedures

As in any study, certain sampling limitations were imposed. Such limitations must be considered both in interpreting the study results and in generalizing from them. By design, the original concept of the study was limited to those mathematics teachers in Mississippi who were new to teaching mathematics in the fall of 1985 or 1986. Further, the study was limited to a sample of the students of those teachers. Although a small honorarium was to be paid, not all teachers identified as eligible would agree to participate and finally return the necessary data forms. The study could not be completed without the approval of the teacher's superintendent and principal, hence further limitations to the study.

Based on conversations with Mississippi's Director of Teacher Certification, expectations were that about 150 teachers would be eligible. Furthermore, each teacher was expected to teach about 130 students daily. That would yield 19,500 students likely to qualify as subjects, far more than the $30,000 budget could finance. Thus, the study was limited by the number of students who could feasibly be a part of the research database.

Such limitations may impact some purposes of the study relative to generalizations to larger or more regional populations. However, the field

test of the research design, data gathering, and processing yielded valuable lessons for the expansion of the study.

*The population universe includes all teachers new to teaching mathematics in Mississippi at the opening of school in either 1985 or 1986.

*The selection was done by the Mississippi State Department of Education, Office of Teacher Certification.

*The SEIL Certification Status math teachers is a term applied to those teachers within the population universe who not only volunteered to participate in the study, but actually completed a usable set of student and teacher instruments.

*The SEIL Certification Status Math students are students of SEIL Certification Status Math teachers who participated in the study and on whom data were provided by the teacher and the student.

Instrumentation

Two types of instruments were designated specifically for this study: (a) instruments that would allow for recording existing data for use in the study, and (b) survey that would elicit specific perceptions and attitudes.

In the full report appendices A through G presented those data gathering instruments, as well as copies of the Soares Affective Measurement Series. A brief description of each of these and a research base follows.

Teacher Demographic Information (SDE files) was designed specifically for completion by the staff at the Office of Certification on each teacher new to teaching mathematics in Mississippi in 1985 or 1986. Information was completed by the Department and formed the initial database for the study.

Teacher's Biographical Inventory (Self-Report) was designed specifically for completion by teachers who volunteered to participate and finally sent in the data sets. Data from this file were added to the database.

Student's Demographic Information (Teacher Report) was designed specifically for completion by participating teachers on a maximum of 35 students. Information from these forms was added to the data base by associating each teacher with his/her students.

Student's Biographical Information (Self Report) was specifically designed for completion by each student for whom there was a Demographic form.

Again, all of these data were added to the teacher/student database.

Secondary data were used from three sources and included tests and assessment inventories gathered primarily for other purposes, but pertinent to this study.

The National Teacher Examination (NTE), published by Educational Testing Services, Inc. of Princeton, New Jersey, are well-known measures of teacher preparation and are used by the Mississippi State Department for certification purposes. Drawing from MSDE files, scores were obtained for the study on the NTE Common or Core (revised) Examinations as well as Mathematics Specialty Area Tests.

The National Teacher Examination (NTE) tests are standardized examinations which provide objective measures of academic achievement for college students in teacher education programs, for college students entering or seniors completing teacher education programs, and for advanced candidates who have received additional training in specific fields.

The Mississippi Teacher Assessment Inventory (MTAI), an adaptation of the Georgia inventory, was adopted by the MSDE as a part of the teacher certification and tenure process. MTAI was later approved by the Mississippi Board of Education as the process for determination of state merit teacher pay raise.

The Affective Perception Inventories by Soares and Soares (1986) are a series of instruments designed to assess self-perceptions of teachers and students as well as teacher and student attitudes toward particular subjects. The Soares teacher instruments selected for this study were:

Self-Perception Inventory (T) Form SC_T, an assessment of how the teacher's views himself/herself as a teacher.

Self-Perception Inventory (T) Form RS_{pro}, an assessment of the teacher's view of how he/she is seen by his/her colleagues.

Mathematics Perceptions Form A, an assessment of how the teacher feels about mathematics.

The Basic Skills Assessment Program (BSAP) is a minimum skills test developed by the MSDE for grades 3, 5, 8, and 11 as a part of the Education Reform Act of 1982. The BSAP has scales in Reading, Mathematics, and Written Communication. Items are based on "core" skills published by the MSDE in the State Curriculum Structure.

The Functional Literacy Examination (FLE) was developed by the MSDE for grade 11 as a requirement for high school graduation. Items are functional in nature, taken from life situations. The FLE has subscales in Reading, Mathematics, and Written Communication.

The Soares student instruments selected for the study were:

Mathematics Perception, Form I & A, an assessment of the student's view of himself/herself as a mathematics student.

Teacher Rating Inventory SPI/SM, an assessment of the student's concept of his/her mathematics teacher.

Statistical Analyses

Data gathered for this study, were entered into a microcomputer database "anchored" on each teacher. As additional information was gathered on the teacher and/or his/her students it was entered into the data base. The BERE uses the personal computer version of the Statistical Packages for Social Sciences (PC-SPSS) for data analyses.

The revised research questions centered on a study of the differences among the "routes of entry" groups of first and second year mathematics teachers in Mississippi. Statistics were selected that allowed for the best examination of those differences. Analysis of variance was selected as the most appropriate and robust statistic for determining differences among the four routes of entry group for this pilot study.

Analysis of variance (ANOVA) is a technique that provides for the comparison of two or more population means. ANOVA also provides for analyses where cell size or population group are of different sizes; thus ANOVA was the basic statistic utilized for comparing the performance of mathematics teachers based on their route of entry into teaching.

The use of descriptive statistics is fundamental to the pilot study both for describing the various populations and subpopulations that are a part of the study and for an analysis of the level of generalizability. Numbers, frequency distribution, mean, and standard deviation, for various responses were completed.

Chi square ($\underline{X}^2$) tests were applied to the data on anticipated and actual cell sizes based on the four routes of entry to determine if the study sample of 52 teachers is representative of the total population of 123. $\underline{X}^2$ also was applied to student group data to determine representativeness and generalizability. $\underline{X}^2$ is a goodness of fit test to determine if the expected frequencies and the observed frequencies of a particular set of observations "fit" the data set.

Methodology

Four areas related to research methodology are briefly presented in this section of the presentation; operational definitions, data gathering, response rates, and generalizability.

Operational Definitions

Two sets of terms are unique to this study and are basic to understanding its operation and outcomes; alternative routes to certification and level of content preparation. These are directly related to the Mississippi teacher certification process. Although the southeastern states have a variety of irregular routes to teacher certification, these four alternative routes to certification align the study to the state certification process. Thus the

SEIL Certification Status Math teachers were studied based on their routes of entry into mathematics teaching using the following terms.

Alternate route 1, COE - Completed a regular teacher education program with a mathematics emphasis.

Alternate route 2, CAS - Completed a liberal arts (college of arts and sciences) program in mathematics and either took enough education courses to become certified or tested out above the 51st percentile on the NTE

Alternate route 3, ADD - Completed a regular teacher education program in another area and added a mathematics endorsement either by taking additional courses or by testing out above the 51st percentile on the NTE

Alternate route 4, EMG - Had emergency certification in mathematics

The SEIL Certification Status Math teachers were studied on the basis of the level of mathematics content in their preparation. Their level of content preparation was classified according to the following terms of levels:

1. 0-18 semester hours of general mathematics
   Includes courses covering topics such as introductory content (e.g., introduction to algebra), fundamentals of algebra, number systems, informal measurement, or other lower level (freshman and sophomore) mathematics courses which DO NOT ADDRESS COLLEGE-LEVEL ALGEBRA, TRIGONOMETRY, GEOMETRY OR CALCULUS CONTENT.

2. 6 semester hours of college algebra and trigonometry or equivalent (e.g., functions, introduction to calculus).

3. 7-17 semester hours of mathematics content
   Includes courses covering college algebra, trigonometry, geometry, measurement, or other lower level mathematics courses; calculus, linear algebra, college geometry, probability, statistics, or other upper level mathematics courses. DOES NOT INCLUDE ANY HOURS IN GENERAL MATHEMATICS CONTENT.

4. 18-23 semester hours of mathematics content
   Includes courses covering college algebra, trigonometry, geometry, measurement, or other lower level mathematics courses; calculus, linear algebra, college geometry, probability, statistics, or other upper level mathematics courses. DOES NOT INCLUDE ANY HOURS IN GENERAL MATHEMATICS CONTENT.

5. 24-30 semester hours of mathematics content
   Includes courses covering college algebra, trigonometry, geometry, measurement, or other lower level mathematics courses; calculus, linear algebra, abstract (modern) algebra, college geometry, probability, statistics, or other upper level or graduate level mathematics courses. DOES NOT INCLUDE ANY HOURS IN GENERAL MATHEMATICS CONTENT.

6. B.A. in mathematics or 31-41 semester hours of mathematics content - Includes courses covering college algebra, trigonometry, calculus, linear algebra, abstract (modern) algebra, college geometry, differential equations, probability, and statistics, numerical analysis, or other upper level or graduate level mathematics courses. DOES NOT INCLUDE ANY HOURS IN GENERAL MATHEMATICS CONTENT.

7. B.S. in mathematics OR at least 42 semester hours of mathematics content - Includes courses covering college algebra, trigonometry, calculus, linear algebra, abstract (modern) algebra, college geometry, differential equations, probability and statistics, numerical analysis, or other upper level or graduate level mathematics courses. DOES NOT INCLUDE ANY HOURS IN GENERAL MATHEMATICS CONTENT.

8. M.A. or M.S. in Mathematics of Ed.S. in Secondary Education with emphasis in mathematics.

9. Up to 30 semester hours of mathematics above the master's degree.

10. More than 30 semester hours of mathematics above the mater's degree.

Data Gathering

Two sources of data gathering for the study were the Mississippi State Department of Education, Office of Certification and the subject teacher and his/her students. The study used an Office of Certification employee to gather and report the eligibility information data on the "Teacher's Demographic Information" form. Using the MSDE certification files the information was reported on 123 teachers who were new to teaching mathematics in Mississippi in the fall of 1985 or 1986. Information from these forms were microcomputer processed as the original database. Subsequently, four of the 123 teachers left their teaching assignments. Five teachers were deleted because their superintendent or principal did not agree to their participation. Letters of request for participation were sent to the remaining 114 teachers in the sample. Teachers indicated their willingness to participate in the study by returning a stamped post card with their name, address, and telephone number. As a result, 59 teachers returned post cards indicating a desire to participate; conversely, 55 did not respond and were assumed to be unwilling to participate. Data forms were sent to the 59 teachers on May 1, 1987. Seven teachers did not return data sets.

An honorarium incentive was built into the project for participating teachers. Each teacher who completed the packets was paid $15.00 for the teacher forms and $1.00 for each student who participated. Most teachers received about $50.00. Teacher honorarium paid on the project amounted to a total of about $2,500.

Scores for the 123 original teachers on the Mississippi Teacher Assessment Inventory (MTAI) were gathered from the University of Southern Mississippi's statewide data files. The MTAI was completed for all

Mississippi teachers as a part of the State's merit raise program. Date from the nearly 25,000 teachers were stored at USM's computer center. MTAI data files were arranged by school district codes, then by teacher's certification number issued by SDE upon certification. From the study data files a list of teachers arranged by the USM sequence was mailed to USM and scores were returned to the BERE and added to the study database.

As would be expected in a study of this nature and complexity, data gathering proved to be a frustrating and time consuming task. After agreeing to participate, two teachers withdrew from the study. Finally, however, there were 52 Mississippi mathematics teachers and 1,469 of their students in the study.

Response Rates

The original plan was to identify teachers who were new to teaching mathematics in Mississippi in the fall of 1985 and 1986. Utilizing the resources of the Office of Certification in the Mississippi State Department of Education, 123 teachers were identified. Teacher Demographic Information (SDE file) was completed on each teacher. Teachers who agreed to participate in the study and whose principal and superintendent also agreed and who finally provided information packets on themselves and their students were in final study group. Fifty-two teachers returned data sets for the study. For 493 of the 1,469 students in the study demographic form data were not available. From the 52 SEIL certification status math teachers student biographical and demographic forms were received on 1,469 students. There was data elements available on approximately 1,469 for some variables. For other variables, only 976 students will be used.

Four teachers from the 123 had left their teaching assignments. Five teachers had superintendents or principals who did not want them to participate, 59 teachers returned cards indicating a willingness to participate, 55 indicated an unwillingness to participate by not returning postcards showing approval. Again, 52 teachers provided complete, usable information to the study; again they also provided data on 1,469 of the 5,602 students enrolled in their classes.

A graduate student was given the list of the 55 mathematics teachers who did not return a postcard and attempted to contact these people either at school or at home to determine as accurately as possible why they did not wish to participate. The project administrator worked with the telephone interviewer concerning extreme tact and to assure the interviewee that we were only seeking information. Nine (16%) of those we attempted to contact were no longer with the school, a part of the "turn over" in years one and two. Eighteen (33%) respondents without exception said they wanted no more paperwork for whatever reason. One teacher said she just wasn't interested. Others could not be contacted or would not return our calls. Hidden within these attempts to reach teachers is an important piece of information: 13 of the 123 first and second year teachers (about 10%) had left their positions.

Generalizability

In order to generalize the results of the study, it was necessary to provide evidence that supports the assumption that the 52 participating teachers were representative of the 119 who would have been eligible (123 minus 4 who left MS). The study also needed to show that the 976 students on whom complete data were available are representative of Mississippi secondary school students. In order to provide statistical evidence that our 52 participants are representative of the 119 eligible teachers the following variables were investigated:

Route of Entry
Level of Content Preparation
Sex
Race

In order to provide statistical evidence that the 976 students in the study are representative of the secondary students of Mississippi, the following variable were investigated:

Race
Sex
Socioeconomic Status
Grade Enrolled

Prior to a discussion of the results, the problem of generalizability must be addressed. The basic assumption underlying generalizability is that the sample actually studied is representative of the population of concern. Thus, there are two inferences that needed to be explored: (a) Do the 52 teachers who agreed to participate in the study represent the 123 teachers who were eligible for the study? (b) Do the 1,469 or 976 students of the teachers who participated represent the high school students (approximately 200,000) in Mississippi?

To respond to (1) above four variables were analyzed: route of entry, level of content preparation, race, and sex. It is assumed that if the sample of 52 teachers is representative of the total population (123) there will not be significant differences among the variables.

TABLE 1

Chi Square for Routes of Entry

Total population by routes of entry and study population are shown below.

	#	%	Expected Distribution	Actual Distribution
COE	79	64.23	33	38
CAS	17	13.82	7	6
ADD	19	15.45	8	5
EMG	8	6.50	3	3

$X^2 = 2.02$

$p < .001$.

An analysis of the "level of content" preparation was analyzed to help determine if the 52 SEIL teachers were representative of the 123 teachers. Table 1 presents the X^2 analysis of these data.

In analyzing the representativeness of the student sample, the following variables were available: race, sex, SES (free lunch), grade level enrollments, BSAP and FLE means. From existing State records the project obtained data on the total secondary student population for these analyses.

An examination of these scores, though they do not assume representativeness, indicated that when teachers were asked to select students for participation, they did not necessarily select only the better students. The 11th grade mean scores were very nearly the same, the eighth grade means were about 8 points apart. The SEIL students mean was lower than the state mean in one case. The utilization of the Z test for analyses of the population means for large samples was applied in each case. In two cases, the 11th grade BSAP, and FLE, the sample was found to be representative of the population at the .05 or greater level.

By the preceding analyses of the "input" variables on both teachers and students through the calculation of seven chi square analyses for goodness of fit and three Z tests we can conclude that the sample of teachers are indeed representative of the teacher population of concern to this study. However, there may be concern that the students included in the study are not truly representative. Chi square computations for grade enrolled and for socioeconomic status and Z for 8th grade in mathematics do not support representativeness, while chi square for race and sex do support an assumption of representativeness as do the Z tests for Grade 11 grade BSAP and FLE. The

capability to generalize form the results of this study to all teachers new to teaching mathematics in 1985 or 1986 in Mississippi is supported, More caution is required when generalizing from the 976 students in the study to either all the students of the 123 original teachers or to all secondary students in Mississippi public schools.

Results

This section of the presentation briefly reviews the results of the study organized around the three research questions most of the tables and graphs are omitted in order to conserve space. Again, the full study is available from SEIL or BERE.

Results

Results for Research Question 1

What overall differences exist among mathematics teachers who have taken different routes of entry into mathematics teaching with respect to the following characteristics:

A. level of general knowledge?
B. level of mathematical knowledge?
C. level of pedagogical knowledge?
D. attitude toward mathematics?
E. attitude toward teaching?
F. development of career interests in mathematics?
G. development of career interests in teaching?
H. self-perceived command of mathematics content?
I. self-perceived teaching effectiveness?
J. expectations for student performances?
K. knowledge of student performance levels?
L. students' patterns of interest in a mathematics career?
M. students' patterns of interest in a teaching career?

Evidence

ANOVA results which used the routes of entry as the independent (input) variables and the variables named above in the table titles as dependent (descriptive) variables were completed. Results from the Teachers Biographical Inventory concerning self-judgments of mathematics knowledge and teachers effectiveness were analyzed. Only two of the six variables of concern to this study showed a significant difference at the .05 level or better; Soares Mathematics Attitude and Soares RSpro (a measure of how teachers feel colleagues see them). On NTE Math the CAS teachers had the highest mean score (581.1765); EMG had the lowest mean score (572.323), but there was not a significant difference. On the Soares mathematics attitude scale COE teachers had the highest mean score (31.1944) and CAS teachers earned the lowest (20.4000). On the Soares RSpro scale the EMG teachers earned the highest mean score (55.0) while the lowest mean score was for CAS teachers (31.3). Route of entry into mathematics teaching does not significantly impact either NTE Mathematics, NTE General Knowledge, NTE Professional Knowledge, or Soares SC_T (teacher's self-perception as a

teacher).

Further, when asked the questions regarding SEIL teachers' perception of themselves as to the knowledge of mathematics and teaching effectiveness the results were mixed relative to the route of entry. COE teachers generally see themselves more effective as teachers, though there is little difference among the groups relative to their self-perceived ability to handle more complex mathematics subject areas.

Continuing an analysis of other variables in Question 1, the following are variables that were concern:

* development of career interest in mathematics
* development of career interest in teaching
* expectation for student performance
* knowledge of student performance levels
* student patterns of interest in a mathematics career
* students patterns of interest in a teaching career

Two questions were asked of SEIL Math teachers to determine their development of career interest in mathematics began and what stimulated it. There are very few cases for routes of entry other than COE; therefore, one must be cautious in drawing conclusions or interpreting results. A majority of the COE teachers (62%) indicated that they had become interested in a career in mathematics by the end of junior high school. All of the group reported that they had become interested in a mathematics career prior to finishing college. The CAS group, on the other hand, was more divergent in the development of their career interest in mathematics equally reporting elementary, senior high, and after college as the times their interest in a mathematics career developed. Teachers classified as ADD reported two peak periods of development in mathematics career interest; one early, by the end of elementary school and one later during high school and college. Teachers classified as EMG indicated a later development of a career interest in mathematics.

The results indicated by all four groups shows that COE teachers show early development of interest in a mathematics career; CAS teachers tended to report a broad range of time when their interest in a mathematics career developed; and EMG teachers tended to report mathematics career interest development in later years.

For COE and CAS teachers the attraction to a mathematics career began with experiments and problem solving, since this was reported first by both groups. The second most reported attraction for COE teachers was "things learned on their own," "people" was third for the COE and second for CAS. ADD teachers split between experiments and problem solving and things learned on their own. EMG reported a split between experiments and people. CAS and ADD

teachers seem similar as do CAS and EMG in the process of the development of a mathematics career.

Two questions were asked of SEIL Certification teachers to determine their development of career interest in teaching; questions concern when a teacher became interested in and what attracted them to teaching. Differences do exist among the four routes of entry relative to their career development into teaching. First, COE teachers are attracted to teaching by teachers who have taught them, whereas non COE teachers are attracted mostly for other reasons. There is little difference among all SEIL certification status math teachers relative to when teaching interest first started.

The development of career interest in teaching and in mathematics seems to follow similar patterns for the SEIL certification status math teachers regardless of their route of entry. Given the small number of teachers in the classifications CAS, ADD, and EMG, a pattern of career development is still discernable. It seems to support a conclusion of a more rational selection process for COE teachers that develops earlier and is influenced by the teachers of future teachers.

Two questions were asked of SEIL certification status math teachers about their students to assist in determining the teachers' knowledge of student performance level; a question concerning the students' mastery of course objectives in previous grades and a question regarding the students' present knowledge of course objectives. COE teachers felt that 38.5% of their students knew less than 25% of the course objectives upon arrival and that two-thirds of their students mastered 75% or more of the course objectives. Results for the ADD teachers were strikingly similar showing one-third entering with less than 25% mastery but that 72% had mastered 75% or more of the course objectives. Although the CAS teachers felt that students arrived with more mastery (19% at less than 25% mastery) they agreed with the COE teachers regarding present level of mastery (67% and 75% or more mastery). EMG teachers seemed to perceive mastery questions differently indicating that 61% of the students arrive with less than 25% mastery and only 54% master 75% or more of the course objectives.

A series of questions were asked of SEIL Certification Status math teachers to determine their expectation for student performance. The first question asked the teacher the percent of students that should earn grades of A, B, or C, and F. The data show almost no difference among the four groups regarding the assignment of B's and C's. Also, all SEIL certification status math teachers, regardless of route of entry groups assigned B's and C's at about the rate they expect students to receive them. The use of A's, however, shows that COE and ADD teachers assign A's at the same rate they expect them, where CAS and EMG teachers expect more A's than they actually assign. CAS teachers seem to show higher expectation for their students since they expect less than 5% to fail but actually give F's up to 10% of their students; EMG teachers show the same tendency. CAS teachers think more students should be performing higher since they expect 25 to 75% of the students should receive A's, but actually assign A's to 5 to 25% of their students. Differences do

exist among the four groups relative to the use of A's and F's but no differences exist among the groups regarding the use of B's and C's.

Two questions were asked of students of SEIL Certification status Math teachers to determine their patterns of interest in a mathematics career; a simple "yes-no" question of interest in a mathematics career and a question concerning what is interesting about mathematics to the student. Although, more students of ADD and EMG teachers indicated a career interest in mathematics the difference was about 17%. Approximately 40% of all students expressed a career interest in mathematics, however these 560 students were proportionately divided among the four route of entry teachers. Similar results were found when one examines the question regarding what students find interesting about mathematics; that is, to review the "%" for COE, CAS, ADD, and EMG, the differences found among the five alternatives are small and involve a small number of students. Career interest patterns in mathematics among students do not seem to be a reflection of the teacher route of entry into mathematics teaching.

Student interest in teaching careers show some data of relevance and interest to those concerned with the teacher labor market. Less than one quarter of all students expressed a career interest in teaching. Again, very little difference existed among students of the four route of entry groups (COE, CAS, ADD and EMG). Of interest is that 28.5% of the students of ADD teachers, about 4.5 percentage points higher than the next closest, indicated a career interest in teaching. The students of these ADD teachers also expressed a higher interest in math careers in general. ADD teachers are more likely to have had teaching experience in another field since their mathematics certification was an added endorsement. Students of CAS teachers show the least interest (18%) in a teaching career. Across all four groups the percent interested in teaching was 24.5, a very small number of students.

Discussion

Research question one examined characteristics among mathematics teachers who had taken four routes of entry into the profession. Of major concern were teacher performance on the NTE and teacher attitude toward mathematics. The study looked at career patterns of the students and their teachers. Also of concern were teacher's self-perceptions of their teaching effectiveness and their perceptions of student performance. Overall results were mixed with a few variables providing significant differences. CAS teachers performed somewhat better on the NTE Math test than the others. COE teachers have a higher mathematics attitude score (Soares) than the others and they feel their colleagues see them as more effective (Soares RSpro). Only small differences existed among the four groups and their students on the other variables: career patterns, professional knowledge, general knowledge, self-perception and student expectations.

Turning to "What about teaching do you like best?", one point seems most relevant--very few students indicated that they were influenced by teachers to become a teacher (2.6%). Referring to previous data a total of 27% of those presently teaching were influenced by their former teachers. Today's teachers are not recruiting others as effectively into the profession as did their

teachers. Although many students seem adamantly opposed to a teaching career a nearly equal number seem to like the concept of working with young people.

Generally, route of entry into teaching mathematics seems to impact content knowledge with college of arts and sciences graduates scoring higher and attitude toward mathematics with college of education graduates scoring higher.

Results for Research Question 2

What overall differences exist among mathematics teachers who have taken different routes of entry into mathematics teaching with respect to the following teaching outcomes:

* level of classroom teaching performance?
* performance levels of mathematics students?
* attitudes of students toward mathematics?
* students' perceptions of their teachers' command of mathematics content?
* students' perceptions of their teachers' effectiveness?

An analysis of variance for the four routes of entry for the teachers' scores on the Mississippi Teacher Assessment Inventory (MTAI) were computed. although there was not a significant difference at the .05 level or better, the CAS teachers had the lowest scores ($\underline{M}$ = 179.6154), with COE teachers or ADD teachers almost tied; 188.9 v 189.5. A reasonable assumption is that ADD teachers are experienced, therefore the COE teachers score nearly as well as the experienced teachers. Regarding the value of the MTAI, questions have been raised as to variance among scores. In fact a range of 74 points was found, larger than was assumed.

Student achievement data form the Mississippi BSAP test in Grades 8 and 11 and the FLE test in Grade 11 for students of SEIL certification status math teachers based on their routes of entry into teaching were compared. Test results are recorded in average percent correct (APC) scores. Tests of significance of differences, though easily attainable, were not computed because of the small size of the various groups. Indications of significant differences among these various size groups could be misleading and lack robustness.

Teachers in the study, in all probability had no students in some grades tested. Therefore, extreme caution is necessary when drawing conclusions from the information. Students of COE teachers had higher 8th grade BSAP scores than CAS or ADD teachers' students. Any further inferences are not justified because of the small number of students.

Data concerning the students' perception of the SEIL certification status math teachers' knowledge of mathematics and effectiveness as a teacher based on two questions from the students' Biographical Data Form were compared. When asked if their present SEIL teacher could teach more difficult courses, the percent of students agreeing was nearly the same for all four groups of teachers (COE - 72.4, CAS - 68.1, ADD - 72.3, and EMG 74.2). Although the CAS score is noticeably lower, the difference is not significant. Responses to

other options for the same question is not significant. Responses to other options for the same question were quite similar. Clearly, route of entry does not impact students' perceptions of teachers' mathematics knowledge. However, COE teachers seem to score better than others relative to student perception of teaching ability. A larger percentage of students viewed COE teachers as better than CAS, ADD, or EMG teachers. Perhaps more importantly, 5% of the EMG teachers were viewed by their students as being "Not Good."

ANOVA results for students' scores on the Soares Mathematics Attitude Survey based on route of entry assignments of SEIL certification status math teachers were computed. No significant difference among students' mean Math Perception scores for the four groups of teachers were found. Although students of CAS teachers had the highest mean score and students of ADD teachers the lowest mean, the difference between the two was less than 1.4 points within a range of 34 points. Route of entry for the teacher apparently does not impact students' perceptions of or attitudes toward mathematics.

The ANOVA indicated significant difference ($p < .01$) among the four groups on scores from the Soares Survey of Student Perception of Teacher Effectiveness. Based on results from 1,396 students who took Soares, SPI/SM, CAS teachers were perceived as the least effect ($\bar{X} = 47.635$) while the COE ($\bar{X} = 52.842$) and the ADD teachers ($\bar{X} = 53.696$) were seen as more effective than CAS but not as effective as COE or ADD.

ANOVA results for the student scores on the Soares Teacher Perception Inventory based on the route of entry groups of SEIL Certification status math teachers were computed and a significant difference at the .01 level or greater were found. Students of CAS or EMG teachers did not perceive their teachers to be as effective as either COE teachers or ADD teachers. Since the ADD teachers are probably experienced and the COE groups are more pedagogically trained, it seems reasonable to assume that these factors do make a difference when students judge their teacher effectiveness.

Discussion

The second research question investigated outcome variables designated for the study. Of major concern were differences, if any, in teacher performance among teachers for the four routes of entry groups (COE, CAS, ADD and EMG). Using the Mississippi Teacher Assessment Inventory (MTAI) as the measure of teacher performance no significant differences were found. Looking at student attitude toward mathematics, again by teacher groups, no significant differences were found. However, students' perceptions of teacher effectiveness were significantly higher for COE and ADD teachers than for CAS or EMG groups. There were not enough students in the 8th or 11th grades who reported BSAP or FLE test scores to draw a conclusion, though there was a very slight trend indicating better scores for students of Coe teachers. Responses to student's questions from the biographical form regarding the teachers' knowledge of mathematics and the teachers' quality showed no differences among the groups.

Results for Research Question 3

What relationship exists among route of entry into mathematics teaching and related teacher characteristics and selected teaching outcomes?

Evidence

Dicriminant Function Analysis was used to examine the relationship among characteristics or outcomes and routes of entry. Because the sample sizes were so small for CAS (5), ADD (5) and EMG (3) and when missing data were considered on the first run, it was determined that two groups rather than four should be used for this analysis. The revised groups may be called regular certification (COE teachers, N = 33) and irregular certification (CAS + ADD + EMG, N = 13).

This technique allows one to distinguish between the regularly certified teacher and the irregularly certified teacher based on values of particular variables. Once we have identified variables which discriminate between the two groups, group membership in the actual and the predicted groups are noted to provide a degree of accuracy for our analysis. Variables are sequentially entered into the analyses until the F levels (as value of the contribution a variable makes to group membership) are no longer significant.

Discriminant analyses are then computed on those variables and actual and predicted group membership are compared.

Seven variables were used in the initial discriminant analysis:

(1) NTE General Knowledge (NTE SC2)
(2) NTE Professional Knowledge (Z scores, NTE SC3),
(3) NTE Mathematics Specialty Area (NTEMSC),
(4) Mississippi Teacher Assessment Inventory (MTAISC),
(5) Soares Teacher Self Assessment (SCT),
(6) Soares Teacher Perceived Assessment (RSpro), and
(7) Soares Mathematics Attitude Survey (SMATH).

After sequentially entering three of the seven variables (NTEMSC, MTAISC, and SMATH), the F levels were insufficient for further computations. However, the three variables used had significant values: NTEMSC, $F = 23.33$ sig $< .001$; SMATH, $F = 29.85$, sig $< .001$; MTAI, $F = 20.84$, sig $< .001$.

Table 1 presents the results of the discriminant analysis for regular and irregular certified mathematics teachers. An examination of the tables shows a Wilks Lambda of .5206 and a canonical correlation of .6924, which indicates that approximately 60% of the variance (R^2) associated with regular-irregular certification was explained by the three variables. This analysis yielded a Chi-square of 24.808 (df=3) and was statistically significant at the .01 level of confidence or greater.

Discussion

Results of classification based on the discriminant analysis are presented in Table 3. The analysis correctly classified 97% of the regularly certified teachers and 57.1% of the irregularly certified teachers. Finally, 91.49% of the cases were correctly classified using the three variables. Our original premise for question 3 was to look at the relationship among the available variables as they relate to whether a teacher is a regularly or irregularly certified teacher. Four of the seven variables provide little discrimination between the two. Three variables shown robust discriminating power. A strong relationship exists among three variables; NTEMSC, SMATH, and MTAISC and the classification of regularly or irregularly certified teachers.

TABLE 2

Results of Discriminant Analyses Showing Differentiation of Regularly and Irregularly Certified Mathematics Teachers

Number of Variant Function	Canonical Correlations	Wilks Lambda	df	Chi Square
3	.6924	.5206	2	24.808*

$p < .001$.

TABLE 3

Results of Classification Based on Discriminant Analysis

Membership Actual Group	#	Predicted Group Reg.	Predicted Group Irr.
Regular Certification	33	32	1
		97.0%	3.0%
Irregular Certification	14	8	6
		57.1%	42.9%

*Percent of grouped cases correctly classified - 91.49

Summary Findings

There were two basic purposes for this study: (a) to field test the procedures and processes proposed in the research design phase of the longitudinal study and to recommend any modifications; and (b) to determine if teachers, or their students, perform differently having entered mathematics teaching via different routes, at least in their initial years in teaching.

This field test of a research design plan studied the effect of certification status on the performance of mathematics teachers and their students. Fifty-two of the 123 first and second year mathematics teachers in Mississippi and 1469 of their students participated in parts of the study. The study utilized four routes-of-entry into teaching (college of education, college of arts and science, adding an endorsement, and emergency certification). The study examined five outcome variables (teacher performance, student performance, student attitude, student perception of teacher effectiveness, and of teachers' command of mathematics content). The following teacher characteristics were used as descriptive variables: general knowledge, mathematical knowledge, pedagogical knowledge, attitudes toward mathematics and teaching, career patterns of students and teachers, and knowledge and expectation for student performance.

Results of the study were mixed, since no specific avenue of entry into teaching mathematics stands out as clearly superior. Graduates of colleges of arts and sciences seem to possess somewhat greater content knowledge and to perform almost equally as well as teachers as graduates of colleges of education. Teachers who add mathematics endorsements to an existing certificate achieve and perform much like graduates of colleges of education, as would be expected. Teachers on emergency certificates show some tendency to perform and achieve less effectively but the differences are not statistically significant. Students perceive graduates of colleges of education as more effective teachers, however, no significant differences were found in student achievement.

Examination of the characteristic variables that were studied reveals very few differences among teachers who enter mathematics teaching from traditional or irregular (alternative) routes. The study was unable to acquire enough data on student achievement to draw significant inferences. This is a major weakness of the study.

One major conclusion, however, stands out. It is possible, reasonable, and necessary to complete a long-range, multistate study using the design and methodologies established for this pilot study. This study need not be limited to mathematics or to any single subject area. Clearly, enough was learned from the pilot effort to make the longitudinal study more effective and efficient.

Implications for Practice

Policy recommendations and implications for practice must be cautiously approached based on the results of this study. Only a single state,

Mississippi, participated in the study. The total population eligible for the study was 123 teachers new to teaching mathematics in 1985 or 1986. Complete data were available on 52 of these teachers. Results did show that sample to be representative. Thus, policy implications and recommendations are not forthcoming from this study. The mixed results, the lack of strong or consistent pattern, and the shortage of student achievement data make one cautious about any interpretations of recommendations. Certainly, no data or information from this study should slow attempts to bolster the mathematics teacher labor markets by seeking irregularly certified or alternatively prepared teachers. If anything, the varied results produced a preponderance of evidence to support seeking teacher candidates outside traditional preparation and certification channels.

Recommendations

The study set out two major purposes: to pilot test the design plan and its implementation; and to determine if, at least in a pilot state, route-of-entry into teaching makes a difference. The implications for each purpose will be examined separately. The pilot test of the design and procedures showed that the long-range study across six southeastern states is a real possibility and could prove successful. Major changes are implied: decrease the number of characteristics and outcome variables to a minimum; simplify the data management process by using existing data files; and continue to look at cognitive knowledge, such as NTE scores, and teacher performance, such as MTAI scores. The study of attitudes, perceptions, career patterns, and expectations does not seem cost effective, nor do they provide information that is stable or robust. Extra efforts should be made to get student achievement data as an outcome measure. Many states now have basic skills and functional literary testing. Some states are adding end-of-course testing. The inclusion of these data would greatly enhance the overall study. Since the study included a small number of teachers who entered teaching outside the traditional college of education route 37 COE to 15 others), an extra effort should be made in any long range multistate study to seek the participation of teachers with irregular certification.

By identifying and employing at least part-time data managers in each participating state, a long-range, multistate research project on the effects of preparation and certification on the performance of mathematics teachers and their students is feasible and it would provide significant policy implications.

Finally, a longitudinal, multistate study is strongly recommended and certainly needed. As a minimum it should cover six states and five years, for best results it should cover nine states and 7 years. The evidence seems to show that teachers are less likely to leave the profession once they have seven years experience. Further surveys on teacher mobility indicate less mobility than was originally suggested, especially among experienced teachers, and that regional mobility is more common than national especially in the South.